THE WHEAT JOINTWORM AND ITS CONTROL

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Straw-fallen wheat—injury caused by the wheat jointworm

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FARMERS' BULLETIN 1006
UNITED STATES DEPARTMENT OF AGRICULTURE

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief

Washington, D. C. October, 1918

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WASHINGTON : GOVERNMENT PRINTING OFFICE : 1918

THE WHEAT JOINTWORM ranks next to the Hessian fly as a wheat pest in the majority of the wheat States east of the Mississippi River and in parts of Missouri. At present, however, absolutely nothing is being done to control it. In fact, the present farming practices and systems of rotation afford it ideal breeding conditions.

This jointworm can be controlled in Virginia, Tennessee, and Kentucky by plowing down wheat stubble deeply after harvest wherever this is practicable and does not interfere with the growing of red clover and grasses. Rye may be substituted with safety for wheat in the more northerly States, such as Michigan, where jointworm injury is severe, because it is not subject to attack by this jointworm. Rye is a good bread grain, cover crop, green manure, and nurse crop for clover.

THE WHEAT JOINTWORM[1] AND ITS CONTROL.

CONTENTS.

WHEAT JOINTWORM AND HESSIAN FLY.

The wheat jointworm is a very small grub which lives in stems of wheat, sucking the juices of the plant and causing a swelling in the stem. The egg from which it hatches is laid in the stem by an insect resembling a small black ant with wings. This insect attacks no

FIG. 1.—Adult female of the wheat jointworm. Greatly enlarged. (The head is tilted back somewhat so as to show the groove in front.)

other kind of plant. The injury which it does to wheat is very distinct from that caused by the Hessian fly, yet the depredations of these two insects are often confused by farmers. This paper is intended, therefore, to give a brief outline of the life history and the

[1] (*Isosoma*) *Harmolita tritici* Fitch.

nature of the injury to the plant by the jointworm so that any farmer may readily recognize its work and be able to apply the measures of control herein recommended.

STATES IN WHICH WHEAT JOINTWORM DAMAGE OCCURS.

The wheat jointworm (fig. 1) occurs in more or less destructive abundance in all of the more important wheat-growing States east of the Mississippi River. (Fig. 2.) It has also crossed the Mississippi into the eastern half of Missouri, where it is causing considerable damage to the wheat crop, and it has been found in the extreme southeastern part of Iowa. This insect undoubtedly occurs to a greater or less extent wherever wheat is grown east of the Mississippi River. That portion of the great wheat belt lying west of the Mississippi River, excepting the limited areas just mentioned, thus far has escaped its ravages, and the insect has never even been found in that region excepting in Missouri.

FIG. 2.—Map showing present known distribution of the wheat jointworm in the United States.

ECONOMIC IMPORTANCE.

In destructiveness to wheat the jointworm ranks next to the Hessian fly within the States involved, the damage running into millions of bushels. Without a doubt it surpasses that insect in destructiveness during some years, from the very fact that the farmers generally have learned in a measure how to control the depredations of the Hessian fly and are applying this knowledge to a considerable extent. The opposite is true for the jointworm, as little or nothing is being done by the farmers to control this pest. In fact, the present practices and systems of rotation furnish ideal conditions for its development.

NATURE OF INJURY.

Fortunately for all concerned, this jointworm never attacks any plants other than wheat, and this greatly simplifies control measures.

When a wheat plant has become infested, no outward sign whatever may appear. The presence of the jointworm can be detected when the plant is nearly mature, however, by pinching the plant between the forefinger and the thumb. Infested plants will be found to contain a hard, woody place in the stem just above the second or third joint from the ground, or there may be several such places. If these hard places be chipped with a sharp knife, larvæ or grubs will be found inside the stem in distinct little cells or cavities (fig. 3).

FIG. 3.—Wheat jointworm cells opened, showing the mature larvæ. About natural size.

Very often the point of infestation is very noticeable, there being wartlike swellings (fig. 4) on the stem. Another very good indication is the presence in the field of a number of fallen or lodged plants. This can be readily observed from a distance, and the condition is often attributed by farmers to the work of the Hessian fly. A close examination of these fallen plants, however, will show hard, woody galls at the point where the plant bends over (fig. 5). When a plant breaks over from Hessian-fly attack, no such woody, hard place in the straw will be found, and near the bend or break there will be found either

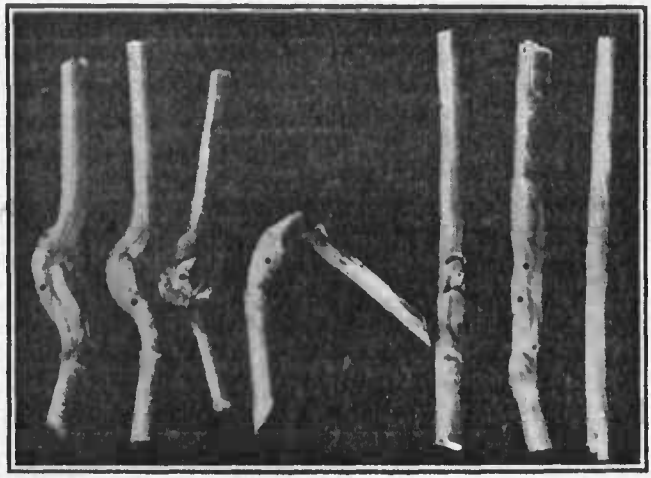

FIG. 4.—Sections of wheat stems, showing typical galls or injury from the wheat jointworm. About natural size.

greenish-white, footless grubs or flaxseed-like objects between the leaf sheath and the main stem.

The damage to a field by the jointworm may vary from slight injury to total destruction. In the latter case practically all the plants fall. Figure 7 and the title-page illustration show distant and close

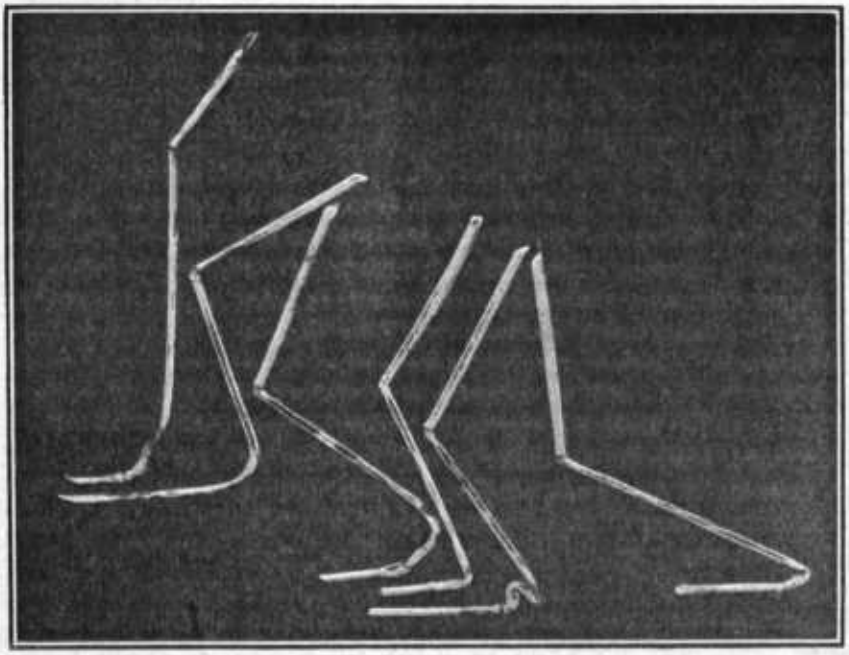

FIG. 5.—Typical fallen straws infested by the wheat jointworm, showing the angle at which they bend over. Considerably reduced.

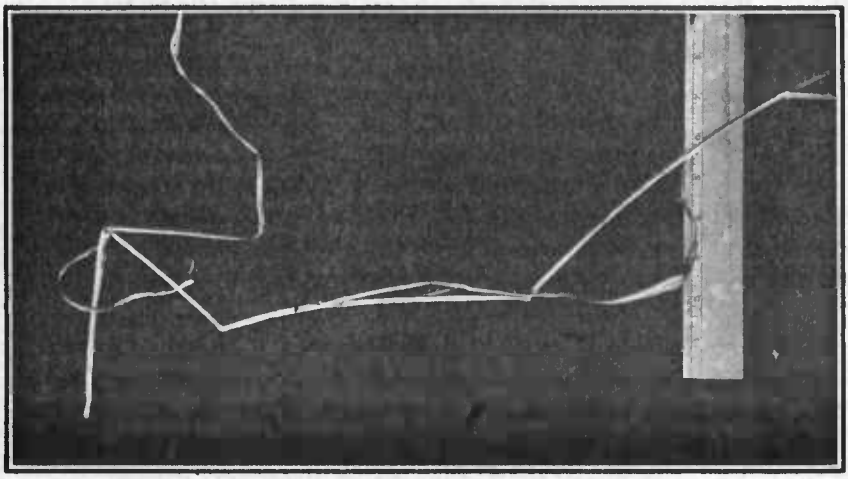

FIG. 6.—Showing point at which the fallen straws resulting from wheat jointworm attack are cut by the binder. Considerably reduced.

views, respectively, of badly lodged wheat. When such wheat is cut by the binder the fallen plants are cut just below the head (see fig. 6), and thus the heads are lost, as they will not be bound in the bundle or sheaf, and should they be bound the necessary subsequent handling will cause them to be lost from the butts of the bundles.

It is not necessary, however, for large numbers of the plants to lodge or fall to reduce the yield greatly, especially if the percentage of infestation is high. The hardened, knotty places in the wheat stems interfere with the normal flow of the sap and the proper nour-

FIG. 7.—A badly infested and straw-fallen wheat field. Injury caused by the wheat jointworm.

ishment of the developing kernels, leaving them not only lighter in weight but also considerably smaller in size.

Figure 8 shows the actual yield of grain from 85 heads from healthy plants in comparison with that from 85 heads of equal length from plants with one and two points of infestation, respectively, and with that from 85 heads of equal length from infested plants that were lodged or fallen. Strong, vigorous wheat is not injured proportionately as severely as poorer wheat, and this is shown by the yield from 85 heads from infested and uninfested plants from good and poor wheat (figs. 9 and 10). In the latter case all the heads were not of equal length, and the average yield per head was taken for the infested and uninfested from both the good and the poor wheat to show the relative difference. The heads were carefully measured and the grain was thrashed very carefully by hand, not a kernel being left

in the heads. The difference in weight is fully as great as the difference in bulk. This is conclusive proof that even when the plants do not fall or lodge, great injury is done when the degree of infestation is high.

SEASONAL HISTORY.

Like many other insects, the jointworm has four stages in its life history, namely, the egg, the larva or grub, the pupa or resting stage, and the adult or parent insect. There is only one generation a year.

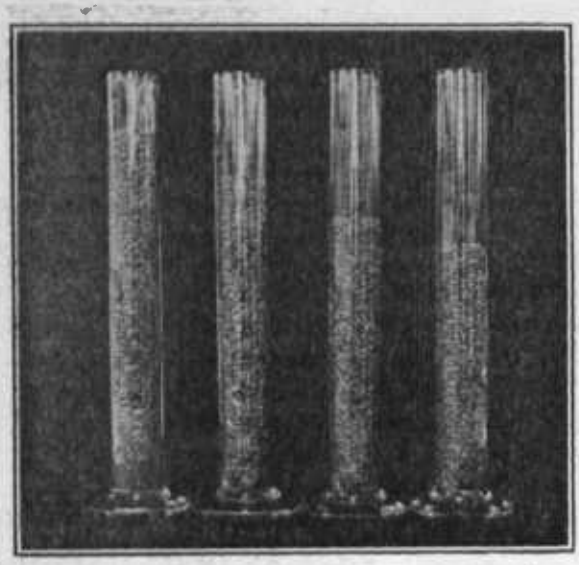

FIG. 8.—Difference in yield from 85 heads from healthy plants (left to right), and the same number from plants infested by the wheat jointworm at one internode, those infested at two internodes, and from fallen straws, respectively. Though all of these heads were the same length, the difference in yield is marked.

THE EGG.

The eggs (fig. 11) are very small, white, and shaped somewhat like a cherry before they are laid. They are pushed down into the wheat stem (fig. 12), one in a place, with a sharp, needlelike ovipositor. Sometimes as many as 15 eggs are pushed into the stem within a space of about 1½ inches. Egg laying occurs shortly after the emergence, during May, by the adults which develop from the larvæ that have overwintered in the stubble. They are laid only during the day and one female may deposit as many as 70 or more eggs. The eggs hatch in about 14 days, more or less, depending upon whether the weather is cool or hot.

THE LARVA OR GRUB STAGE.

The larvæ at the time of hatching are very minute, whitish, translucent little creatures, and they never move from the point in the stem at which they hatch. These grubs are footless and are provided with tiny hooks or mandibles with which they lacerate the tissues of the plant and then suck the juice. By the time the larvæ hatch there is a distinct disturbance in the tissues of the plant and within about a week or two after hatching a cell has formed about each larva. These cells disarrange the tissues of the wheat stem and consequently weaken the stalk at that point. A rain or wind storm at

this time will cause the plants to bend at the point where the cells are, and thus badly infested fields often become badly lodged.

The larvæ reach maturity and stop feeding just before the wheat ripens. At this time they are of a yellowish color and about three-sixteenths of an inch long (fig. 13), occupying a neat little gall or cavity in the walls of the stem, and the stem at this point is very hard and woody.

When the wheat is cut the stubble is left about 7 inches tall and the majority of the larvæ remain undisturbed in the old stubble. As clover and grass are often sown with wheat, the old stubble is left standing for nearly a year, thus furnishing ideal conditions for the development of this pest.

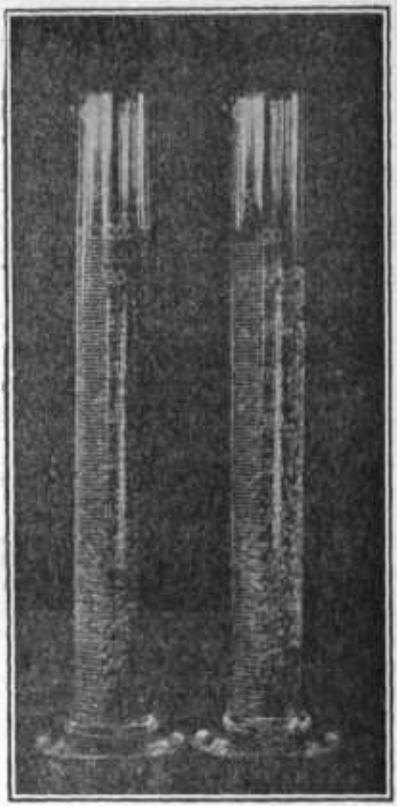

FIG. 9.—Yield from 85 healthy plants (at left) and from 85 jointworm-infested plants from strong, vigorous wheat. Note the relatively greater damage done to poor wheat as shown in figure 10.

THE PUPA OR RESTING STAGE.

The larvæ remain in the old stubble and in November and December about 90 per cent of them change to pupæ (fig. 14). The pupa is about three-sixteenths of an inch in length and at first is of a pale yellow color, gradually changing to a dirty yellow. It remains the latter color until spring and then changes to black. The pupa does not feed on the plant, but remains in the old stubble over winter. In May it changes to the adult, gnaws a small circular hole in the stem, crawls out, and flies away in search of growing wheat.

Large numbers of the pupa are killed each winter in the Northern States by the severe cold, but this also seems to kill about the same proportion of its insect parasites, and as a rule little difference can be noted the following year in the percentage of infestation.

THE ADULT OR PARENT.

The adult insects (fig. 1) usually escape the observation of the average farmer, for they are very small and are not abroad in the

fields longer than from about 10 days to 2 weeks during the year. They are about three-sixteenths of an inch long, black, with four delicate, transparent wings and somewhat resemble winged ants. The jointworm does no damage to the wheat in this stage. As soon as the adults emerge from the old stubble they start in search of growing wheat, and although apparently they are not strong fliers they may be carried a mile or more by the wind, which is the chief agency in disseminating these creatures. A space of a few hundred yards therefore between an old stubble field and growing wheat is no protective barrier whatever.

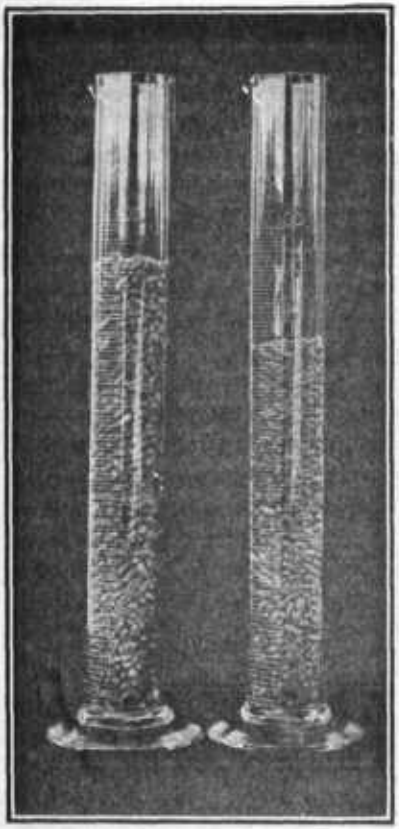

FIG. 10.—Yield from 85 healthy plants (at left) and from 85 jointworm-infested plants from poor, weak-growing wheat. Note the relatively greater injury to this poor wheat than to strong, vigorous wheat as shown in figure 9.

HISTORY OF THE WHEAT JOINTWORM IN THE UNITED STATES.

The wheat jointworm is a very old enemy of wheat. The first record of its appearance was in 1821, when it was observed in Bucks County, Pa. The earliest outbreak on record was in 1848, in the vicinity of Charlottesville, Albemarle County, and Gordonsville, Orange County, Va. In 1851 the wheat of Albemarle County was scarcely worth harvesting. In 1854 the outbreak had assumed such alarming proportions that a "jointworm convention" was called in Warrenton, Fauquier County, Va., to consider the best means of controlling the ravages of this pest.

By the early eighties this insect had become very widespread, causing considerable injury to wheat in Virginia, Ohio, Michigan, and New York. Again in the nineties it claimed serious attention, and during the last 15 years the jointworm has caused constant and serious loss to practically all the main wheat-growing States east of the Mississippi, and for some years has been causing serious loss in southeastern Missouri. At present it is known to have reached nearly across the southern part of this State. For reasons as yet imperfectly

understood it has not established itself elsewhere west of the Mississippi River.

NATURAL ENEMIES.

Without the assistance of numerous parasitic enemies of the jointworm, wheat growing in the Eastern States of necessity would have been abandoned or the growers forced to adopt effective methods of control. The parasites have made it possible usually for the majority of wheat growers to grow fair crops of wheat in spite of the jointworm. But these friends of the wheat farmer can not be relied upon always by any means, as the writer has seen infested fields which yielded only 6 or 7 bushels to the acre as an average.

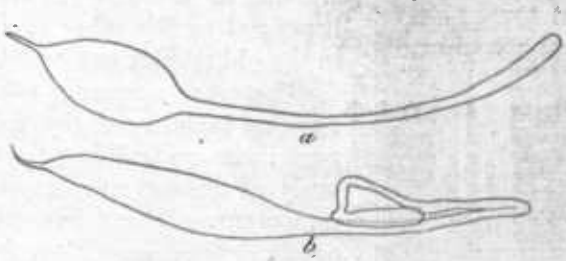

FIG. 11.—Wheat jointworm eggs: *a*, Before oviposition; *b*, after the egg has been pushed down into the plant tissues.

At present three parasites deserve special notice. All are minute four-winged flies in the adult or parent stage, and about the same size as the adult of the jointworm. One (fig. 15) is dark brownish and has three or more generations a year. The eggs are pushed down into the hiding places of the jointworms, and when the young grub hatches from the parasite egg it devours the jointworm. The last generation of the parasite passes the winter as larvæ or grubs in the cells of the hardened pieces of straw of the old wheat stubble and emerges in the spring after the jointworm has begun its development. A second species of parasite (fig. 16) in the adult stage is bluish black and has a life history approximately the same as the preceding, with the exception that there are four or more generations a year, at least in the more southern States. The third (fig. 17) is black, and the average person can not distinguish it from the adult of the jointworm. It differs markedly in life history from the other parasites in that it deposits its egg when the jointworm is only about a fifth grown.

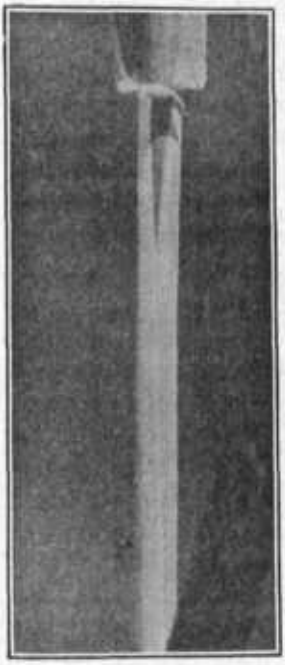

FIG. 12.—Adult wheat jointworm pushing egg down into plant stem. About natural size.

When it hatches the larva devours the jointworm and completes its development on the plant tissues. While the insect actually lives for a part of its life at the expense of the wheat plant, it is entirely dependent upon the jointworm for starting its development and is therefore as truly beneficial as the other species. It also remains in the old stubble over winter as a grub.

FIG. 13.—Full-grown larva or grub of the wheat jointworm. Considerably enlarged.

There are numerous other parasitic and predacious enemies of the jointworm that play a part in its control, but the three parasites previously mentioned are at present by far the most important. *Wheat growers should be warned not to depend upon these insect parasites to prevent jointworm injury to the crop, but to practice consistently the remedies hereafter recommended.*

CONTROL MEASURES.

As previously stated in this bulletin, little or nothing is being done to control the jointworm, and the prevailing methods of farming throughout the region infested by it tend to permit increase of injury rather than control of insect pests, such as the jointworm, Hessian fly, and wheat sawfly, that live from year to year within the wheat stubble.

CONTROL BY CULTURAL METHODS.

The joint worm can be controlled by plowing under wheat stubble after harvest during the summer or early fall, thus burying the stubble containing the pest so deeply as to prevent the emergence of the insect the following spring. But this method should be practiced only where it will not interfere with the growing of clover and forage grasses which are so necessary in maintaining the tilth of the soil.

FIG. 14.—Pupa or resting stage of the wheat jointworm. This is the stage in which most of the jointworms pass the winter in the old stubble fields.

Where the foregoing method is adopted all badly infested wheat should be cut high. If the wheat be tall and vigorous, the stubble should be left about 10 inches high. In other words, all badly infested wheat should be cut as high as practicable with the ordinary binder, so that the great majority of the jointworms will be left on

the field in the old stubble (see figs. 3 and 4) and may be turned under and destroyed.

In southern Kentucky, Virginia, Tennessee, and other Southern and Southeastern States, where double-cropping systems are in general use, it should be possible to plow down the stubble generally and thus easily secure control of the jointworm. Where this is done all volunteer wheat should be destroyed by disking, occasional harrowing, or in other ways, in order to prevent this and other pests from breeding in such plants. In the northern clover-growing regions this method could not be adopted without seriously interfering with clover culture, and should be employed only in cases where extraordinarily severe infestations of the jointworm threaten complete loss of the crop.

FIG. 15.—A wheat jointworm parasite, *Ditropinotus aureoviridis*. Greatly enlarged.

FIG. 16.—A wheat jointworm parasite, *Homoporus chalcidephagus*. Greatly enlarged.

SUBSTITUTION OF SMALL GRAINS IMMUNE TO JOINTWORM INJURY.

The wheat jointworm does not attack any crop other than wheat. Therefore it is possible to substitute with entire safety either rye, barley, or buckwheat for wheat on lands heavily infested with the jointworm. Of the three grains mentioned, rye doubtless is the most suitable substitute for wheat. It may be grown in almost any region where winter wheat will grow, is a satisfactory nurse crop for clover, and can be grown successfully on poorer

and sandier soils than wheat, with less fertilizer. The latter fact is important, because the jointworm usually selects stands of poor wheat upon which to lay its eggs, and jointworm injury is therefore more frequent and severe in such fields than where the crop is in a vigorous condition.

FIG. 17.—A wheat jointworm parasite, *Eurytoma bolteri parva*. Greatly enlarged.

Rye is a good cover, green manure, and grazing crop, and can be grown more safely in some of the Northern States than winter wheat. This is particularly true of Michigan, where jointworm injury is usually severe. Rye is not often severely injured by the Hessian fly or other important insect enemies of wheat. It is also a good bread grain, used largely by many people of this and other countries. The substitution of rye or other small grains for wheat is not recommended as a remedy for jointworm injury except where losses from this cause are of a serious nature and where it becomes absolutely necessary to adopt immediate control measures.

THE PRESIDENT TO THE FARMERS OF AMERICA

[Extract from President Wilson's message to the Farmers' Conference at Urbana, Ill., Jan. 31, 1918.]

"The forces that fight for freedom, the freedom of men all over the world as well as our own, depend upon us in an extraordinary and unexpected degree for sustenance, for the supply of the materials by which men are to live and to fight, and it will be our glory when the war is over that we have supplied those materials and supplied them abundantly, and it will be all the more glory because in supplying them we have made our supreme effort and sacrifice.

"In the field of agriculture we have agencies and instrumentalities, fortunately, such as no other government in the world can show. The Department of Agriculture is undoubtedly the greatest practical and scientific agricultural organization in the world. Its total annual budget of $46,000,000 has been increased during the last four years more than 72 per cent. It has a staff of 18,000, including a large number of highly trained experts, and alongside of it stand the unique land-grant colleges, which are without example elsewhere, and the 69 State and Federal experiment stations. These colleges and experiment stations have a total endowment of plant and equipment of $172,000,000 and an income of more than $35,000,000, with 10,271 teachers, a resident student body of 125,000, and a vast additional number receiving instructions at their homes. County agents, joint officers of the Department of Agriculture and of the colleges, are everywhere cooperating with the farmers and assisting them. The number of extension workers under the Smith-Lever Act and under the recent emergency legislation has grown to 5,500 men and women working regularly in the various communities and taking to the farmer the latest scientific and practical information. Alongside these great public agencies stand the very effective voluntary organizations among the farmers themselves which are more and more learning the best methods of cooperation and the best methods of putting to practical use the assistance derived from governmental sources. The banking legislation of the last two or three years has given the

farmers access to the great lendable capital of the country, and it has become the duty both of the men in charge of the Federal Reserve Banking System and of the Farm Loan Banking System to see to it that the farmers obtain the credit, both short term and long term, to which they are entitled not only, but which it is imperatively necessary should be extended to them if the present tasks of the country are to be adequately performed. Both by direct purchase of nitrates and by the establishment of plants to produce nitrates, the Government is doing its utmost to assist in the problem of fertilization. The Department of Agriculture and other agencies are actively assisting the farmers to locate, safeguard, and secure at cost an adequate supply of sound seed."

"The farmers of this country are as efficient as any other farmers in the world. They do not produce more per acre than the farmers in Europe. It is not necessary that they should do so. It would perhaps be bad economy for them to attempt it. But they do produce by two to three or four times more per man, per unit of labor and capital, than the farmers of any European country. They are more alert and use more labor-saving devices than any other farmers in the world. And their response to the demands of the present emergency has been in every way remarkable. Last spring [1917] their planting exceeded by 12,000,000 acres the largest planting of any previous year, and the yields from the crops were record-breaking yields. In the fall of 1917 a wheat acreage of 42,170,000 was planted, which was 1,000,000 larger than for any preceding year, 3,000,000 greater than the next largest, and 7,000,000 greater than the preceding five-year average.

"But I ought to say to you that it is not only necessary that these achievements should be repeated, but that they should be exceeded. I know what this advice involves. It involves not only labor but sacrifice, the painstaking application of every bit of scientific knowledge and every tested practice that is available. It means the utmost economy, even to the point where the pinch comes. It means the kind of concentration and self-sacrifice which is involved in the field of battle itself, where the object always looms greater than the individual. And yet the Government will help and help in every way that it is possible."

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